CANADA/U.S. SPRUCE BUDWORMS PROGRAM--WEST

FINAL REPORT

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# GENETIC CHARACTERISTICS OF WESTERN SPRUCE BUDWORM POPULATIONS: A VALIDATION TEST OF THE SPRAY EFFICACY MODEL (LEM)


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Stock,
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# INTRODUCTION

Lack of information on the relationship and interaction of pesticide, environment, weather, and host to pest insects has resulted in pesticide field experiments, pilot projects, and operational projects with highly variable results. A probability model was recently developed (through cooperation between the USDA Forest Service, Berkeley, and the University of Idaho) to aid prediction of insecticide efficacy for western spruce budworm and Douglas-fir tussock moth (Force et al. 1982). Model predictions, incorporating data on spray volume and deposit, were compared to actual mortality in three field tests. Prediction success, as measured by a chi-square goodness-of-fit test, ranged from 73-95% (Williams and Robertson 1983).

In summer 1982, spray tests with Orthene (acephate) against western spruce budworm near John Day, Oregon, provided an opportunity for an additional field validation test of the model. Pre- and post-spray larval counts were made to assess mortality, and spray deposit data were collected from cards around trees to obtain estimates of the amount of insecticide actually reaching the insects. This report summarizes results of our cooperative effort to obtain pertinent data in field and laboratory to further test the predictive capabilities of the spray efficacy model. More specifically, our aims were to integrate laboratory dose-response and genetic data with field estimates of spray deposit to predict mortality from insecticide applications, then to assess the level of correspondence between model predicaitons and field-estimated mortality.

## METHODS

A memo outlining our needs for field data and budworm samples (see next page) was sent to all cooperators two months prior to the field tests. Procedures for obtaining spray deposit and mortality estimates were described by Kenney (1983). Techniques for electrophoretic and toxicological assessment of western spruce budworm populations were those described by Haverty and Robertson (1982), Stock and Robertson (1980, 1982), and Willhite and Stock (1983). The model described by Force et al. (1982) was used to integrate genetic, toxicological, biological, and spray deposit data. Predicted mortality was compared to field estimates of mortality using a chi-square test.

From Molly Stock (5/14/82)

**** Information needed for validation test of the spray efficacy model (Force et al. 1982) -- FOR EACH SPRAY AREA AND CHEMICAL:

1) GENERAL INFORMATION NEEDED ABOUT THE AREA TO BE SPRAYED:

   a) Age of infestation (number of years).
   b) Extent of defoliation this year (heavy, medium, or light).
   c) Previous spray use (history) in the area.
   d) Host tree composition (species and approximate percentages).

2) THINGS TO BE DONE BEFORE THE AREA IS SPRAYED:

   a) Collect at least 1000 live larvae (preferably instars 4-5 but 3rd instars are acceptable too) from several different trees representing the host species and stand composition at the spray site. Not all larvae should come from the same tree or only a few trees. Collect from as many trees as possible -- 25-100 trees would be ideal.

   b) Send 300+ larvae to Molly Stock (Dept. of Forest Resources, University of Idaho, Moscow, Idaho 83843 -- phone 208/885-6444). Send 700+ larvae to Jackie Robertson (U.S. Forest Service, Box 245, 1960 Addison St., Berkeley, California 94701 -- phone 415/486-3107). We will provide mailing instructions, permits, and containers. PLEASE LET JACKIE KNOW WHEN AND WHERE TO SEND THESE MATERIALS.

   c) Do a pre-spray count of budworm density. If you have questions on this, contact Jack Berry at Davis (FTS 448-3445) or Carroll Williams at Berkeley (415/486-3442 or FTS 449-3442). A separate pre-spray count should be made on each tree where a Kromekote card will be used (see item 3b below).

3) THINGS TO BE DONE AT THE TIME OF SPRAY:

   a) Estimate instar distribution -- relative proportions of instars (for example, 60% 4ths, 30% 5ths, 10% 6ths).

   b) Estimate spray deposit on Kromekote cards placed either under trees or at the drip line. If you have questions on this procedure, contact Jack Berry (phone number listed above).

   c) Record the dose released (application rate).

   d) Record whether the foliage was wet or dry at the time of spray. (This information is particularly important for Orthene tests.)

4) THINGS TO BE DONE AFTER THE SPRAY OPERATION:

   a) Make a post-spray count to compare with the pre-spray count (item 2c above) to determine mortality. Do this on trees where Kromekote cards were used.

   b) Record if rain falls during the 7 days following spray. If it does rain, estimate how much (in inches) and how long and how often (if more than once.

You should have available to you a study plan recently sent to CANUSA by Carroll Williams.

Molly Stock

## RESULTS

Both genetic and toxicological analysis characterized the John Day 1982 western spruce budworm population as relatively tolerant to acephate. As is characteristic of acephate-tolerant budworm groups, the frequency of EST2 allele 3 was high and the frequency of EST2 allele 4 low in this population (Stock and Robertson 1980). Laboratory-derived $LD_{50}$ values and dose-response data supported this finding.

Budworms sampled on test block 4B were younger (75% 5th instars, 11% 6th instars) than those on test block 4A (64% 5ths, 21% 6ths) at the time of spray. Based on earlier findings that susceptibility of budworm larvae to acephate decreases with age (Robertson 1980), we predicted higher mortality on block 4B than on 4A. Mortality-estimate averages for the two blocks (89.7% for 4B, 76.2% for 4A) support this prediction.

Model-generated predictions of spray efficacy are based on the assumption that there is no rain either right before or within 24 hours after the spray is deposited, or that, if rain occurs, the amount and time of occurrence is known. Rain apparently fell on at least some of the plots soon after spraying. In addition, because some of the cards used to estimate spray deposit were dampened by rain before they were collected, spray deposit estimates were considered less reliable than would have been optimal for a validation test of the model. Nevertheless, correspondence between predicted and field-estimated mortality was higher (63%) than chance would have predicted. In the 6 cases (plots 62, 63, and 67 in 4B, and plots 71, 72, an d 76 in 4A) where significant differences occurred between predicted and field-estimated mortality,

the field-estimated mortality was higher than predicted three times, and lower three times.

## CONCLUSIONS AND RECOMMENDATIONS

Low correspondence between predicted and field-estimated mortality is attributed to undocumented moisture conditions and the different test sites rather than failure of model logic. This study underlines the necessity for obtaining accurate and detailed data on environmental conditions and target insect phenology.

## REFERENCES CITED

Force, J. E., J. L. Robertson, M. W. Stock, and C. B. Williams. 1982. Probability model of insecticide efficacy for western spruce budworm (Lepidoptera:Tortricidae) and Douglas-fir tussock moth (Lepidoptera: Lymantriidae). Environ. Entomol. 11(6):1170-1177.

Haverty, M. I., and J. L. Robertson. 1982. Laboratory bioassays for selecting candidate insecticides and application rates for field tests on the western spruce budworm. J. Econ. Entomol. 75:179-182.

Kenney, P. A. 1983. Relationship of spray deposit to mortality. Draft copy of a report to CANUSA-West.

Stock, M. W., and J. L. Robertson. 1980. Inter- and intraspecific variation in selected Choristoneura species (Lepidoptera:Tortricidae): A

toxicological and genetic survey. Can. Entomol. 112:1019-1027.

Stock, M. W., and J. L. Robertson. 1982. Esterase polymorphism and response to insecticides during larval development of the western spruce budworm. J. Econ. Entomol. 75:183-187.

Robertson, J. L. 1980. Contact and feeding toxicities of acephate and carbaryl to larval stages of the western spruce budworm, Choristoneura occidentalis (Lepidoptera:Tortricidae). Can. Entomol. 112:1001-1006.

Willhite, E. A., and M. W. Stock. 1983. Genetic variation among western spruce budworm (Choristoneura occidentalis) (Lepidoptera:Tortricidae) outbreaks in Idaho and Montana. Can. Entomol. 115:41-54.

Williams, C. B., and J. L. Robertson. 1983. Spray volume measurement as an interface between laboratory and field efficacy data. J. Econ. Entomol. 76:215-218.